Literature

Cohen, M. M. (1970): The somatic karyotype of *Meriones unguiculatus*. J. Heredity **61**, 158—160.
Evans, E. P.; Breckon, G.; Ford, C. E. (1964): An air-drying method for meiotic preparations from mammalian testes. Cytogenetics **3**, 289—294.
Gamperl, R.; Vistorin, G.; Rosenkranz, W. (1976): A comparative analysis of the karyotypes of *Cricetus cricetus* and *Cricetulus griseus*. Chromosoma (Berl.) **55**, 259—265.
Nadler, C. F.; Lay, D. M. (1967): Chromosomes of some species of *Meriones* (Mammalia: Rodentia). Z. Säugetierkunde **32**, 285—291.
Pakes, S. P. (1969): The somatic chromosomes of the Mongolian gerbil *(Meriones unguiculatus)*. Lab. Anim. Care **19**, 857—861.
Sumner, A. T. (1972): A simple technique for demonstrating centromeric heterochromatin. Exp. Cell Res. **75**, 304—306.
Sumner, A. T.; Evans, H. J.; Buckland, R. (1971): New technique for distinguishing between human chromosomes. Nature (Lond.) New. Biol. **232**, 31—32.
Vistorin, G.; Gamperl, R.; Rosenkranz, W. (1976): Analysis of mitotic and meiotic chromosomes of the European hamster, *Cricetus cricetus* (L.). Z. Säugetierkunde **41**, 342—348.
Vorontsov, N. N.; Korobitsina, K. V. (1970): Materials on a comparative karyology of Gerbillinae. Cytology (Leningrad) **12**, 152—157.
Weiss, L.; Mayeda, K.; Dully, M. (1970): The karyotype of the Mongolian gerbil, *Meriones unguiculatus*. Cytologia **35**, 102—106.
Yosida, T. H. (1977): Supernumerary chromosomes in the black rat *(Rattus rattus)* and their distribution in three geographic variants. Cytogenet. Cell Genet. **18**, 149—159.

Authors' addresses: Dr. Roswitha Gamperl, Institut für Medizinische Biologie und Humangenetik der Universität Graz, Harrachgasse 21/8, A-8010 Graz; Dr. Gerda Vistorin, Ruhr-Universität Bochum, Lehrstuhl für Genetik, Universitätsstraße 150, D-4630 Bochum

Feeding habits of the Stone Marten, *Martes foina* (Erxleben, 1777), in northern Burgos, Spain

By M. Delibes

Estación Biológica de Doñana

Receipt of Ms. 16. 2. 1978

Abstract

This study on the diet of the Stone Marten *(Martes foina)* is based on the analysis of 148 droppings and 14 gut contents collected from 1973 to 1977 in northern Burgos, an area of transition between temperate and mediterranean Spain. The results of the analysis are presented as: a. frequency of occurrence of each type of prey and b. as consumed biomass, estimated using the correction factors of Lockie (1961) for the Pine Marten. Seasonal variations in the diet were found. Small mammals (mainly *Apodemus sylvaticus* and *Crocidura russula)* and birds are the most important prey in Spring — Summer, and berries (mainly of *Juniperus* spp., *Rubus* spp. and *Arctostaphylos uva-ursi)* in Fall-Winter. Reptiles, insects, carrion and honey are complementary foods. The Stone Marten appears in the

U.S. Copyright Clearance Center Code Statement: 0044-3468/78/4305-0282 $ 2.50/0
Z. Säugetierkunde 43 (1978) 282—288

ISSN 0044—3468/ASTM-Coden ZSAEA 7

results as a generalist feeder, consuming in the study area a great diversity of animal and vegetable species, mainly taken in rocky forest environments and not in the human surroundings.

Introduction

The Stone or Beech Marten *(Martes foina)* probably arrived to Europe from the Middle East after the recession of the last glaciation (Kurtén 1968; Anderson 1970). Although it is one of the most common carnivores in Europe, its precise ecology is unknown except in a few localities. Heptner et al. (1974) summarize some studies carried out in Russia and Waechter (1975) has a recent paper on the Stone Marten in Alsace (France). In all localities it is an omnivorous species, but in the Soviet Union its diet consists of numerous wild animal and vegetable species, while it is limited in France to those species (many of them domestic) which can be obtained in the human environment. This paper deals with the feeding habits of the Stone Marten in a transition zone between temperate and mediterranean Spain.

Material and methods

We analyzed 14 gut contents and 148 droppings from Stone Martens. Five of the guts lacked any sort of food, hence the number of viable samples was reduced to 157. Of these, 66 (1 gut content and 65 droppings) corresponded to a period from the 1st of March to the 31st of August (Spring-Summer) which coincides with the breeding season and consequent rearing of offspring for Stone Martens as well as that of its principal vertebrate prey. Ninety-one samples (8 guts and 83 droppings) correspond to the period from the 1st of September to the 28th of February (Fall-Winter). The guts come from specimens captured by professional trappers and were preserved in an 8 % formaline solution until they could be examined.

The processing of each dropping was carried out following Lockie (1961). The results are presented in two manners: a. the frequency of occurrence of each type of prey and b. the estimated percentages of the biomass consumed corresponding to each type of prey. In order to estimate the consumed biomass, we have used the same correction factors as those of Lockie (1961) in his study on the Pine Marten *(Martes martes)*, giving to reptiles a factor of 45 (i.e., an intermediate between that of small birds and that of large birds in Lockie), to Orthoptera a factor of 12 and to honeycombs a factor of 4 (assuming that in the average honeycomb the weight of the honey is three times greater than that of the wax, and that honey is digested and wax is not).

Study area

The samples were collected at random between 1973 and 1977 in the northern part of Burgos province, in an extensive area whose axis is formed by the Ebro River and its tributary, the Rudrón River (approximately 42° 44 N and 3° to 4° W). This is a calcareous zone with an altitude of 600—1000 meters, where erosion by rivers and streams has caused narrow valleys and deep canyons with rocky karstic walls. The climate and vegetation indicate the transition from temperate to mediterranean Spain. Kermes and holm oak thickets dominate the landscape, but in the higher zones small stands of beech or Pyrenean oak can be observed. These are the remnants of a once extensive forest that has now disappeared. The area was chosen so that its northern boundary coincides with the southern limit of the Pine Marten distribution in Spain.

Results

The frequency of occurrence and the biomass of the principal types of prey in each period is shown in Table 1.

Altogether, mammals are the group most frequently appearing since they are present in 52.9 % of the samples and constitute 34.8 % of the consumed biomass. They are followed in importance by fruits (in 49.7 % of the samples and 23.5 % of

Table 1

Food of the Stone Marten in northern Burgos

	Spring / Summer no. of samples: 66		Autumn / Winter no. of samples: 91	
	F. O.	P. B.	F. O.	P. B.
Mammals	77.3	46.1	35.2	23.3
Birds und eggs	34.8	26.4	15.4	19.5
Reptiles	9.1	5.0	2.2	3.1
Invertebrates (mainly insects)	40.9	4.6	42.9	5.5
Honey	10.6	0.6	12.1	1.1
Vegetable matter (mainly berries)	19.7	4.9	71.4	42.2
Carrion and other products	9.1	12.4	2.2	5.3

F. O. = Frequency of occurrence expressed as a percentage of the samples; P. B. = Estimated percentage of consumed biomass.

the biomass) and by birds (in 23.6 % of the samples and 23 % of the biomass). The rest of the groups, although some are well represented as far as frequency of occurrence is concerned, have a very slight importance as a biomass.

There is an appreciable seasonal variation in the diet. Comparing the frequency of occurrence in the two periods we are considering here, statistical differences appear in regard to mammals (chi-square test; $p<.001$), birds and eggs ($p<.01$) and fruits ($p<.001$). The first two groups dominate in the Spring-Summer period while fruits dominate during Fall-Winter. Invertebrates and honey are consumed in equal amounts in both periods and reptiles and carrions somewhat more frequently in Spring and Summer.

Mammals

In the 83 samples that contained mammal remains, a minimum of 10 different species were found (Table 2). The prey size range varied between one medium size rabbit (of about 300—400 g) and one white-toothed shrew *(Crocidura russula)* weighing about 10 g. The highest relative frequency of occurrence corresponds to the wood mouse *(Apodemus sylvaticus)*, followed by white-toothed shrews, rabbits *(Oryctolagus cuniculus)*, water voles *(Arvicola sapidus)* and field voles *(Microtus agrestis)*. All the rabbits except one were very small and it is possible that they were captured in their burrows. The hare *(Lepus capensis)* was also very small and the water vole and garden dormice *(Eliomys quercinus)* were young.

In relation to other European localities, it is surprising to see the little relevance of Microtinae in the diet. Without doubt, this is due to the relative scarcity of these rodents in Mediterranean Spain (Herrera 1974; Delibes 1975). Likewise, the importance of shrews, habitually rejected by such other carnivores as cats (Ewer 1973), genets (Delibes 1974), foxes (Macdonald 1977), etc, is very notable. In Southern France, however, shrews are the most common mammalian prey of the Stone Marten (Waechter 1975).

Birds and eggs

Birds and eggs appear in 37 samples and are represented by at least 12 species (Table 2). The prey-size range varied from that of a pigeon (probably *Columba*

Table 2

Occurrences of each type of prey in the samples analized

	Spring / Summer no. of samples: 66	Autumn / Winter no. of samples: 91		Spring / Summer no. of samples: 66	Autumn / Winter no. of samples: 91
MAMMALS			INVERTEBRATES		
Crocidura russula	15	6	Gastropoda	2	1
Oryctolagus cuniculus (juv)	8	1	Orthoptera	6	25
Lepus capensis (juv.)	1	—	Lepidoptera (larvae)	1	—
Eliomys quercinus	—	2	Hymenoptera	2	1
Clethrionomys glareolus	—	1	Coleoptera (imagos)	17	16
Arvicola sapidus (juv.)	4	2	Coleoptera (larvae)	2	—
Microtus agrestis	5	—	Insecta (unident.)	1	1
Pitymys lusitanicus	2	—	Myriapoda	—	2
Microtinae (unident.)	5	—	Arachnida	—	1
Apodemus sylvaticus	11	13	*Australopotamobius pallipes*	2	—
Rattus norvegicus (juv.)	1	—			
Murinae (unident.)	4	2	VEGETABLE MATTER		
Small mammal (unident.)	10	10	Mushrooms	—	1
			Juniperus phoenicea	—	29
BIRDS			*Juniperus* (other species)	—	13
Gallus gallus var. dom.	—	1	*Corylus avellana*	—	1
Columba spp.	4	—	*Rubus* spp.	—	16
Jynx torquilla	1	—	*Rosa* sp.	—	10
Motacilla sp.	1	—	*Sorbus aucuparia*	—	2
Sturnus unicolor	—	1	*Pyrus communis*	—	1
Garrulus glandarius	—	2	*Malus domestica*	—	2
Troglodytes troglodytes	2	—	*Prunus spinosa (?)*	3	—
Phoenicurus ochruros	1	—	*Prunus domestica*	1	—
Erithacus rubecula	2	—	*Prunus avium*	2	—
Turdus merula	1	2	*Prunus avium* var. domestica	1	—
Muscicapidae (unident.)	—	1	Rosacea (unidentified)	4	—
Passer domesticus	—	1	*Vitis vinifera*	—	1
Fringilla coelebs	1	1	*Arbutus unedo*	—	7
Passeriformes (unident.)	9	5	*Arctostaphylos uva-ursi*	4	14
Bird (unident.)	1	—	*Triticum vulgaris*	—	1
Eggs	1	1	Fruit (unidentified)	—	1
REPTILES			OTHER PRODUCTS		
Lacerta lepida	1	—	Carrion	5	2
Lacerta hispanica	3	1	Chocolate	1	—
Lacerta sp.	2	—			
Colubridae (unident.)	—	1			

livia) weighing about 250 g (the chicken is not considered because it is probably eaten as carrion) to that of a wren *(T. troglodytes)* of scarcely 9 g. The great diversity of birds consumed prevent any one species from standing out amongst the rest. Pigeons and blackbirds *(Turdus merula)* are the species most represented. A domestic chicken and a hen's egg, a house sparrow *(Passer domesticus)*, a spotless starling *(Sturnus unicolor)* and perhaps some of the pigeons (in all from four to eight occurrences of a total of 39) are the only prey characteristic of an anthropogenic environment. Most of the remaining species are forest dwellers and live in bush

and thicket areas. At least four of the identified birds were fledglings, and some nestlings were also probably eaten, although they do not leave recognizable remains in the droppings.

We found that, with respect to biomass, seasonal variation in birds consumption is not high, since the majority of large and medium size birds (chicken, jays — *Garrulus glandarius* — black-birds and starling) are captured in the Fall-Winter period.

Reptiles

Reptiles appeared in only eight droppings. One of them was a small unidentifiable snake. Another was a medium size ocellated lizard *(Lacerta lepida)*, two other are *Lacerta lepida* or *Lacerta schreiberi*, and four were small lizards, probably *Lacerta hispanica*. We did not find any amphibian remains, whose absence was also pointed out by Lockie (1961) in his study on the Pine Marten's diet in Scotland. As was to be expected, there is a higher tendency to capture reptiles during the Spring-Summer period.

Invertebrates

Invertebrates appeared in 66 samples (42%) but they represent only 5% of the total biomass. The most important group without question were the insects (90% of all occurrences), especially Coleoptera (mainly beetles, such as *Geotrupes* sp., *Carabus* sp., etc.) and Orthoptera (mainly grasshoppers, also crickets and mole-crickets). Grasshoppers play an important role in the food during the fall. This explains the slight seasonal variation of the invertebrates in the diet.

On two occasions crayfish *(Australopotamobius pallipes)* remains were found in the droppings, which added to the common occurrence of the water vole remains, leads one to believe that the Stone Marten frequently hunts along the banks of rivers and streams. Snails appeared in three samples, on one occasion it was a centipede, and on another sample it was a large spider (Table 2).

Honey

As is well known the taste of Martens for honey and droppings of waxy consistancy and with a strong smell of honey appear all year long. Sometimes even the remains of bees have been found. The small correction factor assigned probably underestimates the role of this type of food as biomass.

Vegetable matter

Some vegetable remains, like leaves, twigs, grasses, etc, seem to be ingested more or less accidentally by the Stone Martens and they have not been considered here as food. There are 78 droppings with vegetable matter, of which one contained mushrooms and the rest fruits. The minimum number of species was 15 (Table 2).

The most frequently consumed fruits were berries from the phoenician juniper *(Juniperus phoenicea)*. They occur in 32% of the Fall-Winter samples and are followed in importance by bearberries *(Arctostaphyllos uva-ursi)*, dewberries and raspberries *(Rubus* spp.) and berries of other species of *Juniperus*. Of a total of 114 occurrences only 6 (5.3%) correspond to cultivated fruits (2 apples, and 1 each to plums, cherries, grapes and wheat). Therefore the overwhelming majority were wild fruits from trees and bushes.

The marked seasonality in the consumption of vegetable matter is caused by the ripening of the majority of wild fruits at the end of the Summer or in the Fall. As

can be observed in Table 2, only fruits of *Prunus* spp. (that ripen from June to August) and occasionally bearberries are consumed in Summer. This explains why the greatest consumption of fruits in Alsace takes place during the Summer, since there the Stone Marten feeds almost exclusively on cultivated cherries *(Prunus avium)* and on rare occasions plums *(Prunus domestica)* (Waechter 1975).

Carrion and other products

In four droppings we found pieces of large mammals bones, accompanied on two occasions by Diptera pupae. Fat and pieces of lung of a large mammal appeared in one gut. It is very probable that on all of these occasions the Stone Marten had fed in a rubbish dump. In droppings collected 30 meters away from a Golden Eagle's nest, the remains of a young lamb appeared once and another time those of an adult hare. Presumably, both prey had been captured by the eagle and the marten had taken advantage of the left overs. Surely then, the marten had not had access to the whole carcass of either of the prey thought to be carrion. Therefore, the assigned correction factors would overestimate the importance of this food as biomass.

In one dropping we found a chocolate bar wrapper. Without doubt, is was eaten along with its contents.

Discussion

In northern Burgos the Stone Marten consumes a great diversity of animal and vegetable food, to the point where in only 157 droppings and guts a minimum of 27 species of vertebrates, 25 of invertebrates and 15 fruits have been identified. Without doubt, the large size of the study area and the long period of time (4 years) during which samples have been collected, are partially responsable for this large trophic diversity, but the fundamental reason is the versality and very small selectivity of the Stone Marten when it feeds (euryphagy).

As with all food generalists, the Stone Marten undergoes marked temporal and spatial variations in its diet, turning to seasonally or locally available animal or vegetable food. Although in this study this aspect is not considered, the inter-annual variations of the diet in relation to years of abundance or of scarcity of diverse prey are probably also pronounced. A possible sexual dimorphism in feeding, that Yurgenson (1975) demonstrated in the Pine Marten, should also contribute to trophic diversity.

The majority of prey consumed by the Stone Marten in Burgos were taken in rocky or forest environments, and not in anthropogenic ones. This fact differentiates Burgos martens ecologically from those of Alsace and makes it similar to the populations of the USSR. This event was predictable since 95 % of the Stone Martens capture in Alsace were taken within 500 meters of villages (Waechter 1975). In our study area during 1976, 90 % of the martens (of a total of 32) were taken at a greater distance from any populated area.

Finally, we would like to point out that the trophic niche breadth of the Stone Martens in our study area confirms once again the well known polyphagy of the species of the genus *Martes*, with a wide range of acceptable food and marked seasonal variations in its diet (see Ewer 1973; Heptner et al. 1974; Goszczynski 1976; and references there).

Acknowledgements

I am grateful to P. Santamaría, D. Arce and A. Delibes for their assistance in the collection of the material. Dr. S. Castroviejo did the identification of some the seeds.

Dr. F. Alvarez, Dr. J. Castroviejo, R. López-Alonso, E. Collado and E. Jiménez helped in various ways. G. Wood did the English translation from the Spanish.

Zusammenfassung

Nahrungsökologie des Steinmarders, Martes foina (Erxleben, 1777), im Norden von Burgos, Spanien

Um die Nahrung des Steinmarders zu untersuchen, sind in den Jahren 1973 bis 1977 148 Exkremente und 14 Verdauungstrakte des Steinmarders im Norden von Burgos gesammelt worden. Dieses Gebiet stellt eine Übergangszone zwischen dem milden und dem mediterranen Klima Spaniens dar.

Häufigkeit und Vorkommen der Nahrungsart sowie aufgenommene Biomasse (in Anlehnung an die Studie von Lockie [1961] über die Nahrung des Baummarders) wurden ermittelt. Es ergaben sich jahreszeitliche Unterschiede der Nahrungszusammensetzung. Kleine Säugetiere (vorwiegend *Apodemus sylvaticus* und *Crocidura russula)* und Vögel sind die wesentlichen Nahrungsbestandteile im Frühling und Sommer, während wilde Beeren (in der Hauptsache des *Juniperus* spp., *Rubus* spp. und *Arctostaphylos uva-ursi)* die Hauptnahrung im Herbst und Winter darstellen. Reptilien, Insekten und Honig sind zusätzliche Nahrung. Im Beobachtungsgebiet ist der Steinmarder ein Raubtier, das eine Vielfalt vegetarischer und tierischer Kost zu sich nimmt. Diese wird in erster Linie aus Fels- und Waldgebieten bezogen und nicht aus der Nähe menschlicher Behausungen.

Literature

Anderson, E. (1970): Quaternary evolution of the genus *Martes* (Carnivora, Mustelidae). Acta Zool. Fennica **130**, 1—132.

Delibes, M. (1974): Sobre alimentación y biología de la gineta *(Genetta genetta* L.) en España. Doñana Act. Vert. **1**, 143—199.

— (1975): Some characteristic features of predation in the Iberian Mediterranean Ecosystem. Proc. XII Int. Cong. Game Biol., Lisboa (in press).

Ewer, R. F. (1973): The carnivores. London: Weidenfeld and Nicolson.

Goszczynski, J. (1976): Composition on the Food of Martens. Acta theriol. **21**, 527—534.

Heptner, V. G.; Naumov, N. P.; Jurgenson, P. B.; Sludski, A. A.; Circova, A. F.; Bannikov, A. G. (1974): Die Säugetiere der Sowjetunion. Bd. 2. Seekühe und Raubtiere. Jena: VEB G. Fischer.

Herrera, C. M. (1974): Trophic diversity of the Barn Owl *Tyto alba* in continental Western Europe. Ornis Scandinavica **5**, 181—191.

Kurten, B. (1968): Pleistocene mammals of Europe. London: Weidenfeld and Nicolson.

Lockie, J. D. (1961): The food of the Pine Marten *Martes martes* in West Ross-shire, Scotland. Proc. zool. Soc. Lond. **136**, 187—195.

Macdonald, D. W. (1977): On food preferences in the Red Fox. Mamm. Rev. 7, 7—23.

Waechter, A. (1975): Ecologie de la fouine en Alsace. Terre et Vie **29**, 399—457.

Yurgenson, P. B. (1975): Sexual dimorphism in feeding as an ecological adaptation of a species. In: Biology of Mustelids: some Soviet Research. Ed. by C. M. King. Yorks: British Library Lending Division, 79—83.

Author's address: Dr. Miguel Delibes, Estacion Biologica Doñana (CSIC), Paraguay 1, Sevilla 12, Spain